# REPRODUCTIVE MORPHOLOGY OF GINKGO BILOBA

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CHENG-LEE LEE

B.S., National Southwest Associated University, 1943
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SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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IN THE GRADUATE COLLEGE OF THE
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# REPRODUCTIVE MORPHOLOGY OF GINKGO BILOBA

In spite of numerous previous investigations of the morphology of *Ginkgo biloba* L., there are many gaps in our knowledge of its life history, especially in the details of fertilization. Accordingly, the present research was undertaken to add to our knowledge of reproduction in this plant.

*Ginkgo* is a dioecious tree assigned to the Ginkgoaceae of the gymnosperm order Ginkgoales. The male strobili for the following year are developed in late summer and assume a definite shape which is retained throughout the winter. The maturation of sporangia in the catkin-like strobilus is acropetal. Each microsporophyll usually bears a terminal hump-like structure with two pendent microsporangia. Layers of a mature microsporangium include the epidermis, hypodermal layers, tapetum, and inner pollen mother cell tissues. A count of the chromosomes in meiosis of the pollen mother cells shows 12 in the haploid condition.

The pollen grain, at the time of shedding, usually contains four cells: the first prothallial cell, the second prothallial cell, the generative cell, and the tube cell. Pollination takes place in May, at which time the ovule secretes a pollen drop to which the pollen grains adhere.

After germination of the pollen grain, the first prothallial cell aborts while the generative cell undergoes a further division forming the body cell and stalk cell. During a later stage of development of the body cell, two blepharoplasts become evident and the spherical nucleus becomes lens shaped. Two vacuole-like structures appear close beneath each blepharoplast and a conspicuous granule appeals beside the nucleus.

The female strobili are borne in clusters interspersed among leaves on the short spurs. A strobilus consists of a long peduncle bearing two ovules, each with a collar at its base. The strobilus primordia are formed in the summer, and in the following spring they develop into rod-shaped

structures, gradually becoming club-shaped at their apices. Later the integument envelops the megasporangium. The megaspore mother cell originates very deeply within the nucellus, and after reduction division a linear tetrad is formed. Only the lowest cell undergoes further development and is designated the megaspore.

Free-nuclear division of the megaspore begins at about the middle of May. Divisions occur simultaneously in early stages and more than a thousand nuclei are formed before the initiation of wall formation. Wall formation proceeds centripetally. The archegonial initials (usually two) appear superficially at the top of the prothallium and each contains a large central nucleus. The archegonial initial eventually divides periclinally to form a cover cell and an inner central cell. The cover cell divides vertically into two neck cells. Gradually the central cell enlarges while adjacent cells form a well-organized jacket layer. The megaspore membrane is first very thin and homogeneous, later becoming thicker. This thick membrane has vermiculate pitting and is perforated by minute tunnels.

In the free-nuclear stage, the cells of the spongy tissue of the nucellus surrounding the prothallium may be multinucleate with extremely large tetraploid nuclei. This tissue is absorbed by the developing prothallium. The integument, after maturation, includes three layers: sarcotesta, sclerotesta, and the inner, thin, fleshy layer.

Chromatin in the nucleus of the body cell is diffuse, but it condenses into chromosomes during division. Each spermatozoid includes a blepharoplast which changes from round to crescent shaped in section and then forms the cilial band. The vacuole-like structure separates from the blepharoplast and moves to the end opposite the cilial tail. Later this vacuole appears to become impregnated with chromatin and probably forms the head of the spermatozoid. One half of the granule near the nucleus of the body cell is included in each spermatozoid. The newly-formed spermatozoid is very flexible, and flows out from the pollen tube through an opening.

Just before release of the spermatozoid, the two neck cells of the archegonium undergo a further division forming four cells which are arranged as a hemispherical protuberance at the top of the central cell. The central cell divides unequally into the ventral canal cell and an egg. Just before fertilization, the egg nucleus elongates toward the upper part of the egg. When the spermatozoid is released from the pollen tube, the egg cell forms a small projection which penetrates among the neck cell. As soon as the spermatozoid becomes attached to the neck, the small projection of the egg retreats, leaving a path through the neck. Only the head of the spermatozoid, which includes the chromatin, penetrates the egg, forming a globular mass which reaches the egg nucleus and forms small granules. Simultaneously the chromatin in the egg nucleus forms another cluster of granules. The union of the two sets of granules in the egg may be designated as the actual fertilization.

The first division of the zygote is periclinal. In telophase, an obscure cell plate is visible but is less evident at a later time. Free-nuclear division continues until 256 nuclei are formed; then simultaneous wall formation begins. As the embryo continues to develop, the cells in the lower part differentiate into the apical meristem of the stem and the apical meristem of the root.

Morphological and anatomical evidence indicates that the Ginkgoales are probably derived from a pteridospermous ancestor. The naked female strobilus may be regarded as a reduced, fertile pteridosperm frond. Similarities in seed structure, the arrangement and structure of the male strobili, and the presence of motile sperm are further indications of relationship with the seed ferns. The pteridosperms, Cycadales, and Ginkgoales, which may be designated as phyllosperms, have evolved separately from the Cordaitales, which are regarded as stachyosperms.

## VITA

Cheng-Lee Lee was born in Chekiang, China on October 1, 1921. He received his elementary and high school education in Chekiang, graduating from the senior high school in 1939. Thereupon, he entered the National Southwest Associated University of China. As an undergraduate he majored in biology, and received the B.S. degree in 1943. From 1943 to 1947 he was a teaching assistant and later was appointed instructor in biology in the National Yunnan University. In the summer of 1947, he entered Academia Sinica as a research assistant in cytology. He arrived in the United States in the fall of 1948 and entered the Graduate College of the University of Illinois, where he was appointed to a research assistantship in botany, a position which he held until he was granted a University Fellow in botany in the fall of 1952. In 1950 he received the M.S. degree and continued his graduate studies at this University. He is a member of the Botanical Society of America and of the honorary societies of Phi Kappa Phi and Sigma Xi. He is co-author with H. W. Li of five papers on cytological studies of sugarcane and its relatives I, II, III, and IV, and studies of speltoid and compactoid types of wheat, Academia Sinica, 1948, and the author of "The anatomy and ontogeny of the leaf of *Dacrydium taxoides*", Amer. Jour. Bot., 1952, and "Structure and development of hypodermis in *Dacrydium taxoides* leaves", Amer. Jour. Bot., 1953.